GROUNDWATER INFORMATION FOR MANAGEMENT OF THE ELLEN BROOK, BROCKMAN RIVER AND UPPER CANNING SOUTHERN WUNGONG CATCHMENTS

WATER AND RIVERS COMMISSION REPORT
SLUI 12
2002
SALINITY AND LAND USE IMPACTS

Water and Rivers Commission

GROUNDWATER INFORMATION FOR MANAGEMENT OF THE ELLEN BROOK, BROCKMAN RIVER AND UPPER CANNING SOUTHERN WUNGONG CATCHMENTS

by

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SALINITY AND LAND USE IMPACTS SERIES

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Ellen Brook by

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Foreword

The Swan Hydrogeological Resource Base and Catchment Interpretation project was a Natural Heritage Trust (NHT) and Water and Rivers Commission (WRC) funded project (NHT 973705). The study areas were three priority catchments of the Swan-Canning rivers—the Ellen Brook, Brockman River and the combined Upper Canning Southern Wungong catchments.

The following were the main objectives of the study:

- To liaise with the Swan Working Group and catchment groups to determine issues, needs and appropriate products.
- To provide baseline groundwater information essential for the catchment groups to implement management plans.
- To compile maps of hydrogeological information at a scale appropriate to the decision-making processes of catchment managers.
- To transfer expertise into the priority sub-catchments by training, publications and advice in interpretation.

This report comprises a brief overview of the areas and management guidelines from the perspective of the groundwater issues. More detailed information can be found in the following project reports, posters and CD-ROM.

Reports
Groundwater information and management options for the Brockman River Catchment SLUI 2
Hydrogeological information for management planning in the Ellen Brook Catchment SLUI 11
Groundwater information for management in the Upper Canning Southern Wungong Catchment SLUI 14

Posters
Managing Nutrient Movement into Ellen Brook
Geology of Ellen Brook
Hydrogeology of Ellen Brook
Salt affected land? Yes! It's a groundwater problem! Brockman River Catchment

*CD-ROM**
Groundwater information and Management Zones for the Ellen Brook, Brockman River and combined Upper Canning and Southern Rivers and Wungong Brook catchments.

> *The data package on the CD-ROM contains the following themes in GIS format: surface water catchments and their subcatchments; hydrogeological zones; water monitoring sites for groundwater and surface water; management boundaries; regional soil surveys; topographic contours; roads; Local Government boundaries; and general climatic data.

Contents

Figures

Tables

Summary

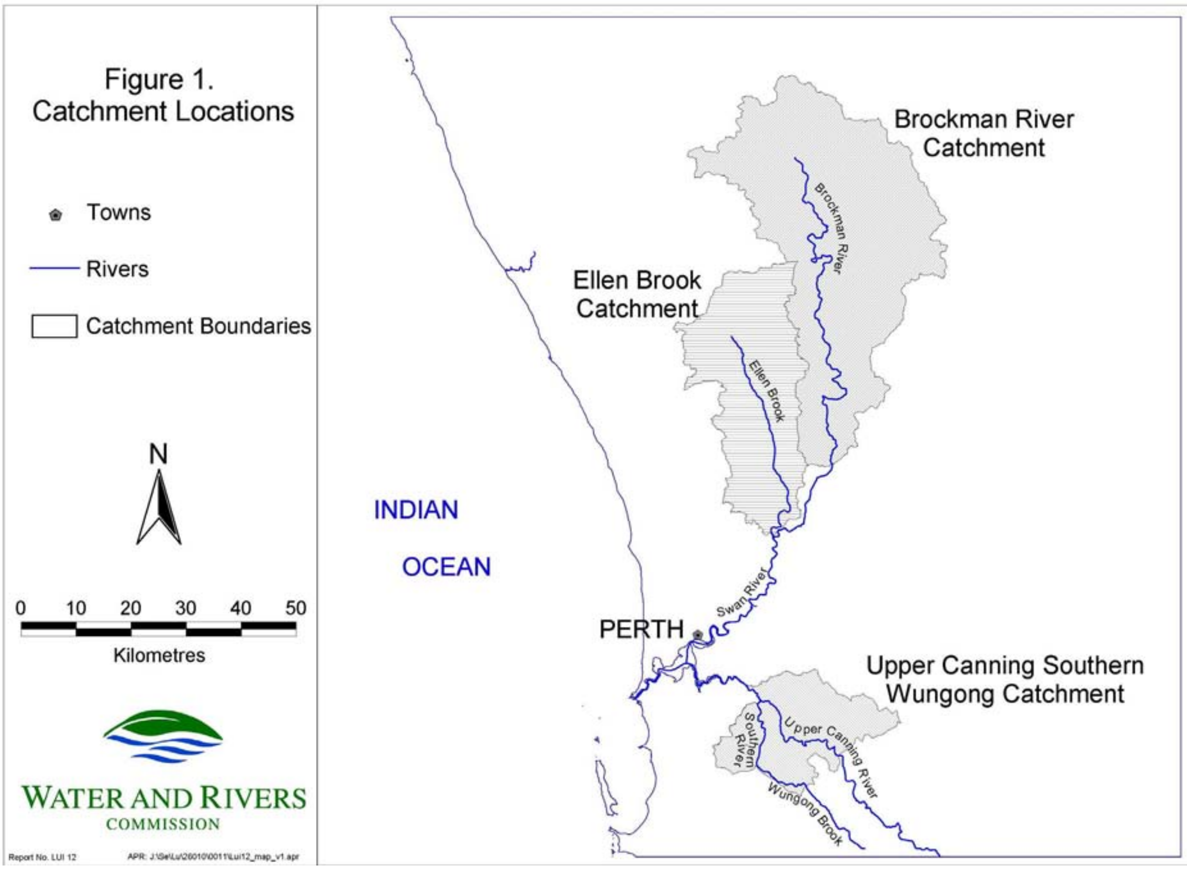
In summarizing the reports listed in the Foreword, this report provides the recommended groundwater-related management actions for the three priority subcatchments of the Swan-Canning rivers.

The Ellen Brook, Brockman River and Upper Canning Southern Wungong catchments (Fig. 1) are three near urban subcatchments of the Swan and Canning rivers experiencing significant land and water degradation as a consequence of extensive land use changes and development.

Erosion, nutrient export and inundation are the significant land and water degradation issues for both the Ellen Brook and Upper Canning Southern Wungong catchments with dryland salinisation a growing problem in all three catchments. Contamination of groundwater by salt or other contaminants is a problem for all three catchments.

The Darling Scarp divides these catchments between the Swan Coastal Plain and the Darling Plateau. Understanding these features and the associated drainage and geology explains much about the groundwater-related issues addressed in this report.

Keywords: Yilgarn Southwest Province, Perth Basin, hydrogeology, catchment water quality, land use planning, Armadale, Bindoon, Bullsbrook, Kelmscott, Muchea, SH5014, SI5002



1 Ellen Brook catchment

The Ellen Brook catchment (Fig. 2) on the outskirts of Perth is in transition from rural to intense horticultural, light industrial and residential land use. Nutrient entry to surface water, inundation of valley flats, salinisation on the plateaus, and erosion of banks and slopes are important groundwater-related issues for management. This study particularly addresses the role of groundwater in nutrient transport to the Ellen Brook and thence to the Swan-Canning estuary.

The clearing and land use history, together with the differing groundwater behaviour in the three distinct geomorphic zones (Swan Coastal Plain, Dandaragan Plateau and Darling Plateau, Fig. 3), have been instrumental in the emergence of the current issues for management and planning. An appreciation of the varied hydrogeological conditions (Fig. 4) is important to achieving good management practice and addressing the environmental issues in the Ellen Brook catchment.

The Environmental Protection Policy (EPP) for the Swan and Canning Rivers recognises that the receiving waters of the Swan and Canning estuarine system provide important economic, aesthetic, recreational, commercial and environmental resources for the State. The Ellen Brook catchment is recognised also for economic and heritage (Aboriginal) significance and environmental values. Four land and water degradation issues, whose management options require groundwater information, are described below and shown in Table 1(a to d).

The Ellen Brook catchment is one of the highest contributors of the **nutrients**, nitrogen and phosphorus, to the Swan-Canning estuarine system. Very high levels of phosphorus and moderate levels of nitrogen are consistently found in the Ellen Brook. Fertilisers, animal wastes and soil-bound nutrients from current land use activities and the impacts of past management within the catchment are the major source of nutrients into the Ellen Brook via surface and groundwater.

The flat plains of the catchment, concentrated on the north-south drainage line, are prone to **inundation** in the winter either through a seasonally high watertable or waterlogging on surfaces with low permeability. These areas suffer loss of production, mobilisation of nutrients and seasonal salinity.

Salinisation is an emerging issue on the Dandaragan and Darling Plateaus. This groundwater issue is widespread throughout the state, especially in the Southwest Land Division.

Erosion is the result of many geologic, geomorphic, hydrogeologic, ecologic, social and other factors in combination. It is a major problem along the scarp face, steep slopes of the plateau and the banks of waterways, but firebreaks, roads and tracks are also of concern. Stream bank erosion and sedimentation are major problems where fringing vegetation is absent or damaged through unrestricted stock access. Stream bank erosion and associated sedimentation is becoming a problem in some of the streams flowing from the Darling Scarp.

Report SLUI 11 applies what we know about the hydrogeology of the Ellen Brook catchment to what it means for management and planning. Table 1(a to d) on the next page duplicates the management actions described in that report. The priority areas for recommended management actions are the environmental management units (EMUs, Fig. 5) defined in a management plan for the Ellen Brook catchment.

1.1 Management guidelines

Table 1a. Management options to reduce nutrient export

Groundwater management objective	*Priority areas (EMUs*)*	*Recommended actions*	*Examples/actions*
Reduce groundwater recharge	SC2	Manage groundwater recharge	Commercial farm forestry - Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Perennial pasture
Minimise nutrients leaching into groundwater	SC1, SC2 and DN1	Best management practice	Fertiliser & irrigation management Improve land practice Application of soil amendment to low phosphorus-retaining soils
Reduce overland runoff	SC2 and SC3	Surface water control	Stream lining to trap and uptake nutrients Planting, graded bank to reduce overland flow
Minimise sediment entry to drainage	SC3, DN1, DN2 and DR11	Control erosion	Planting to filter sediments Planting, fencing, stock control to reduce erosion Perennial pastures

*EMUs are Environmental Management Units.

Table 1b. Management options to reduce inundation

Groundwater management objective	*Priority areas (EMUs)*	*Recommended actions*	*Examples/actions*
Lower groundwater level	SC2	Manage groundwater recharge	Commercial farm forestry, Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Engineering practices: surface water management via shallow interceptor banks or grade banks
	SC3, DN1 and DN2	Reduce waterlogging	Planting species tolerant to water

Table 1c. Management options to counter dryland salinisation

Groundwater management objective	Priority areas *(EMUs)*	*Recommended actions*	*Examples/actions*
Reduce groundwater recharge	Subcatchments draining the Darling Plateau and southern section of the Dandaragan Plateau (DR11, SC3 and DN1). Localised dryland salinisation is evident on the Swan Coastal Plain where shallow water table is coincides with clay-dominated sediments.	Manage groundwater recharge	Commercial farm forestry, Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Engineering practices: surface water management via shallow interceptor banks or grade banks
Lower groundwater level		Manage the groundwater recharge and engineering options	Reducing groundwater recharge as above Engineering options: deep drains (> 1.5m deep), not effective in deep clays; groundwater pumping; relief wells or siphons where depth to groundwater is < 4 m and land surface has slope greater than ~3%
Evaluate remedial actions		Monitoring	Monitoring program either site specific or at catchment level
Public support of management actions		Increased public education and awareness	Public information on catchment targets and why they were selected Education on the causes and management of salinisation Reinforce the key message that the whole community benefits from reducing salinity Encourage active subcatchment groups and community participation Encourage tours of remedial sites, both positive and negative

Table 1d. Management options to control water erosion

Groundwater management objective	*Priority areas (EMUs)*	*Recommended actions*	*Examples/actions*
Stabilise slope	DN1, DN2 and DR11	Prevent erosion	Planting high water using trees Utilising appropriate land/farming practice Engineering practices: surface water management via shallow interceptor banks or grade banks
Stabilise banks	All (except SC1which has none)	Prevent erosion	Riparian vegetation Fencing of stream lines Reduce stock access to stream line

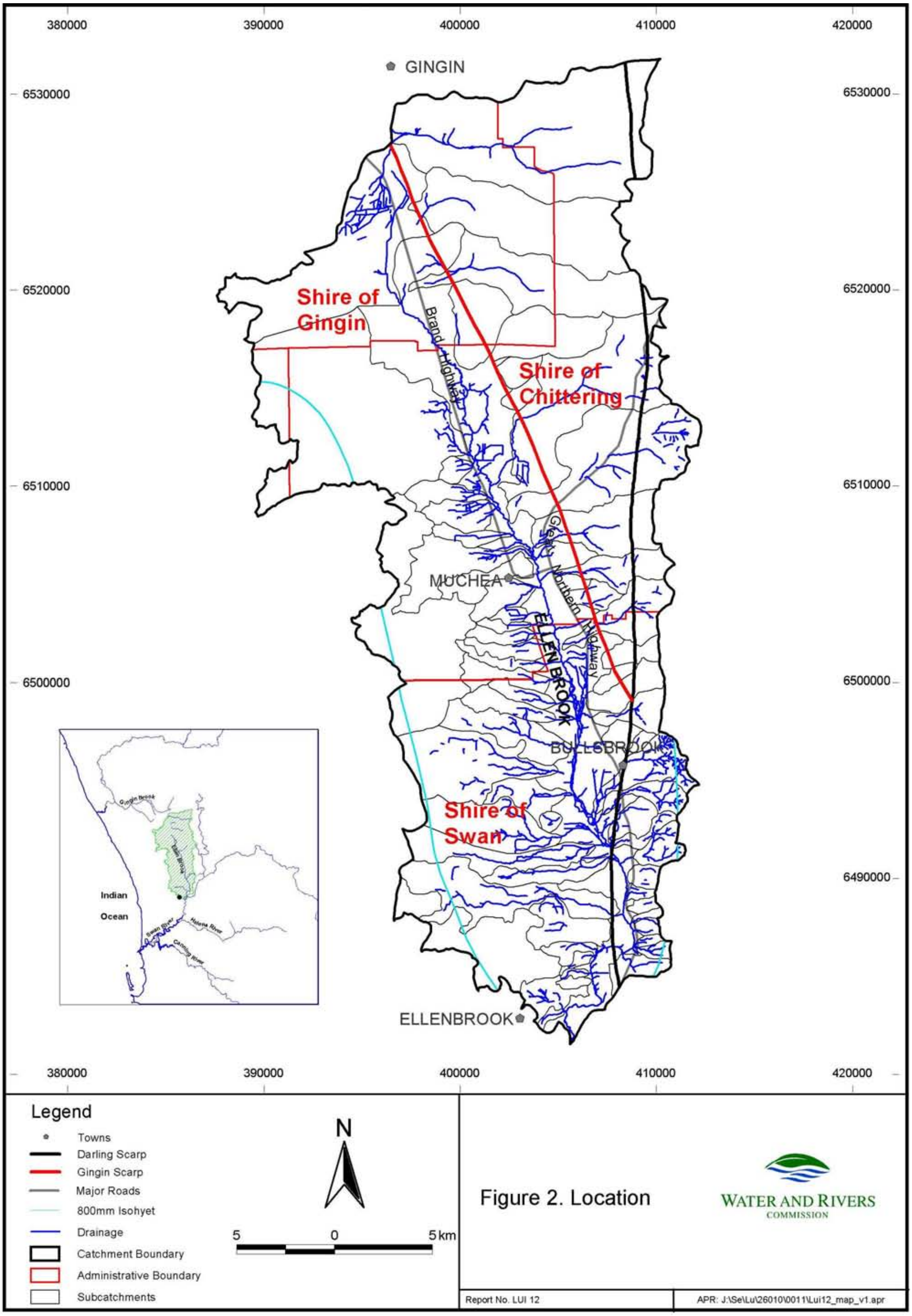


Figure 2. Location

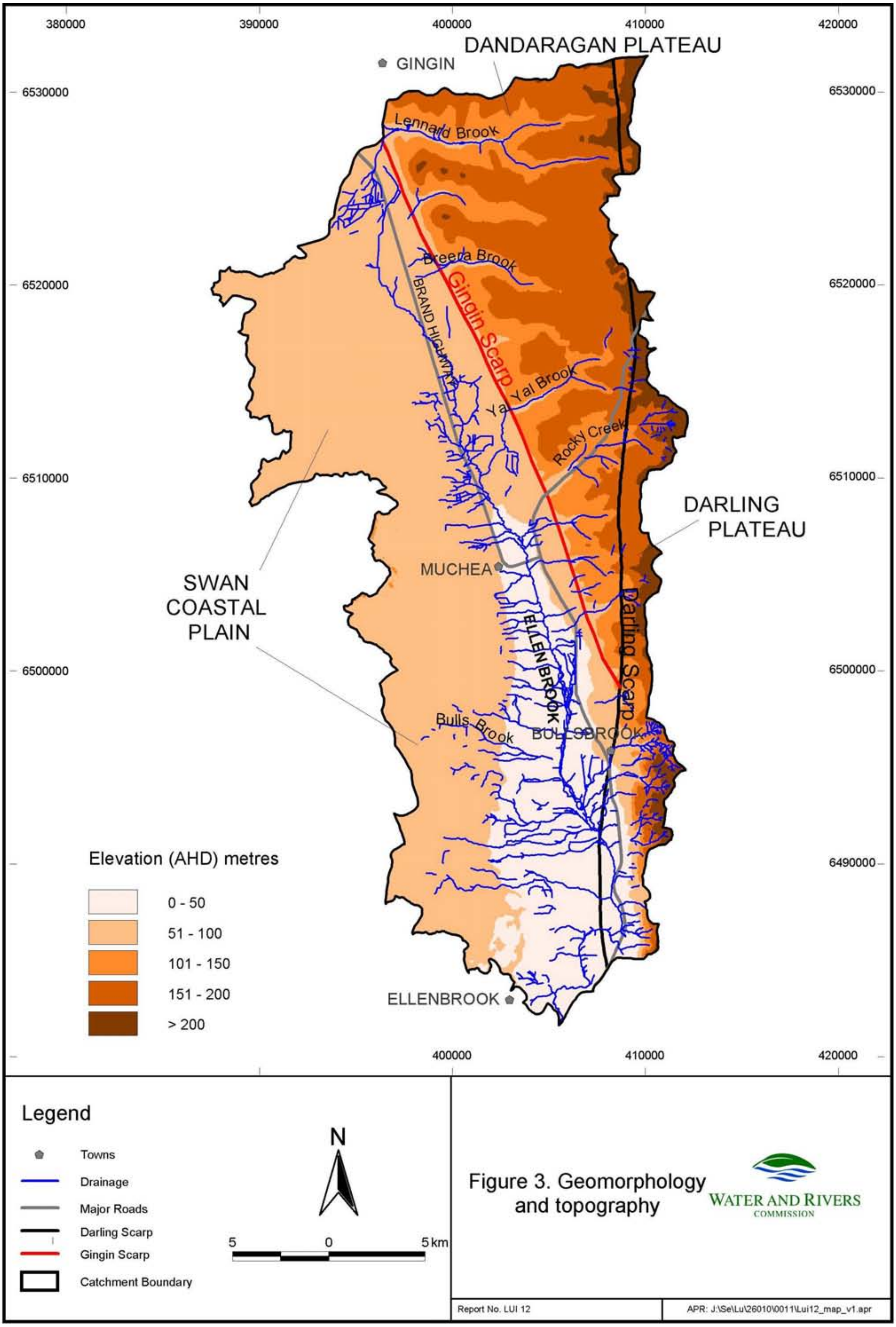


Figure 3. Geomorphology and topography

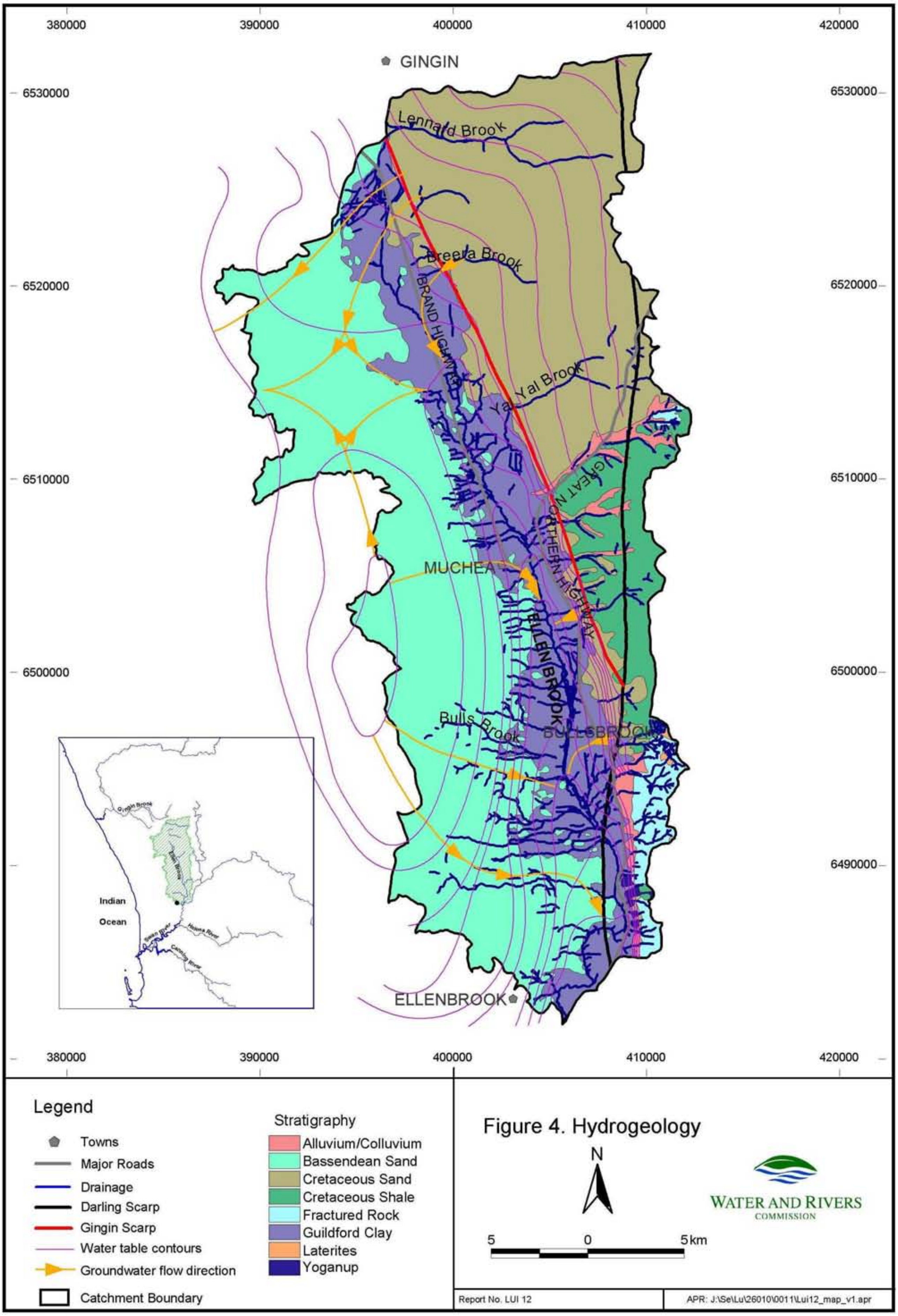


Figure 4. Hydrogeology

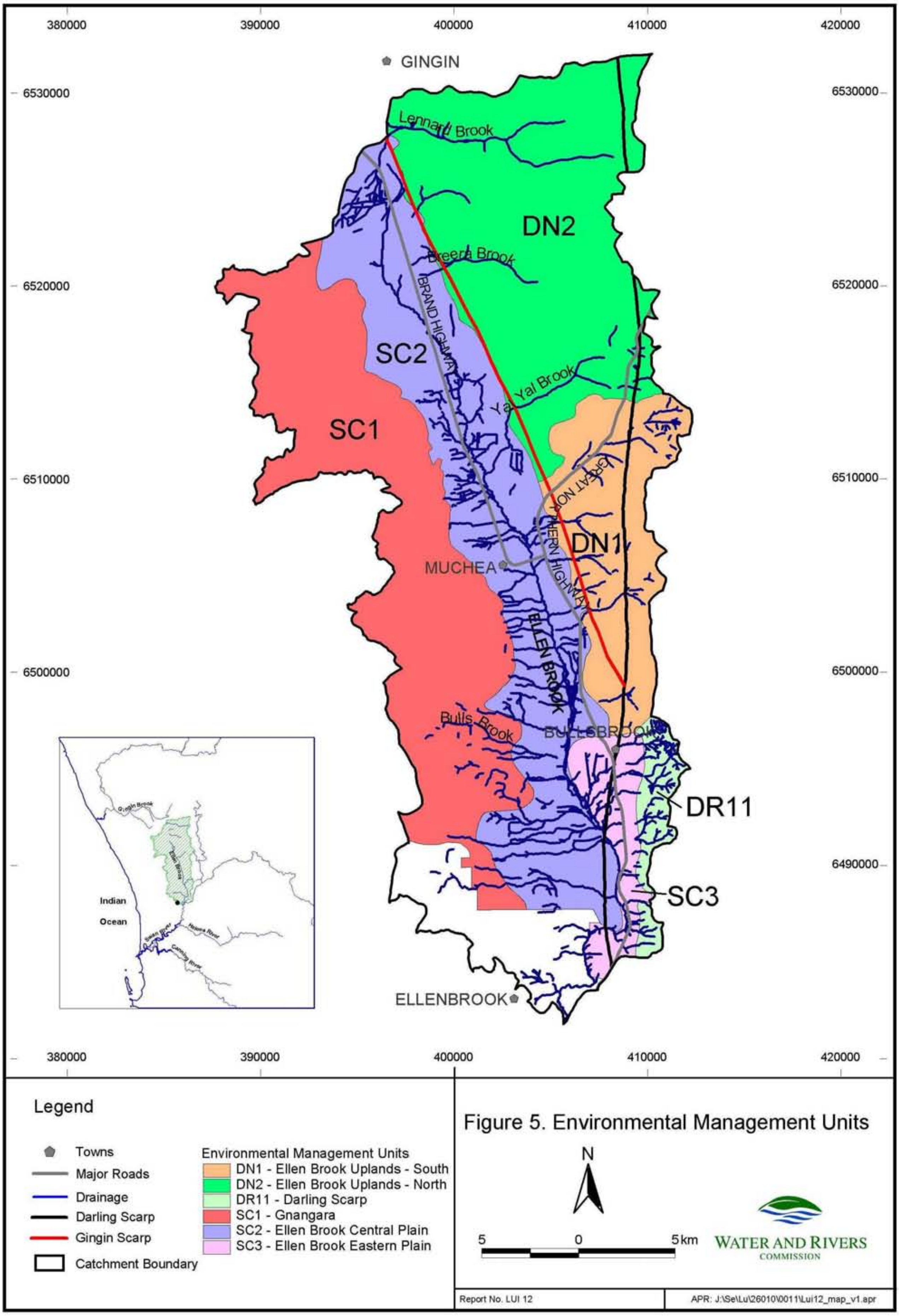


Figure 5. Environmental Management Units

2 Brockman River catchment

The limited good quality groundwater and the development of dryland salinisation are the main groundwater-related issues in the Brockman River catchment. Options for groundwater management include efficient use and protection of existing groundwater supplies through industry awareness, best practice and public awareness and education. Developing dryland salinisation requires groundwater management to reduce recharge or lower the groundwater levels.

There is widespread landholder concern in the Brockman River catchment over emerging dryland salinisation from rising groundwater levels, both of which are reducing agricultural productivity and lowering economic returns. Businesses (such as tourism) that rely on attractions or the physical infrastructure (roads or buildings) are also likely to be adversely affected by these issues. Rising groundwater levels need to be tackled at a catchment level and will require significant community cooperation.

Four groundwater zones are identified (Fig. 6). The regional aquifer in the Dandaragan Plateau is managed as part of the Gingin Groundwater Management Area. The surficial aquifers and the western fractured-rock aquifer zone are both important for private groundwater abstraction in the Brockman Valley. While additional localised groundwater resources are probably available in these two zones, it is unlikely that they will yield large supplies of good quality groundwater. Rising groundwater however has the potential to contaminate these already limited low salinity resources. Groundwater from the eastern fractured-rock aquifer zone is generally suitable for limited irrigation and livestock.

60% of salt discharged by the Brockman River into the Avon River originates in the catchment upstream of Tanamerah monitoring station (S616006, Fig. 6). This north-to-south variation is due to the difference in land use history, geology and rainfall.

Groundwater resources are limited and localised. Developmental and economic demands of the catchment will in places conflict with optimal groundwater management. Managers need to balance the environmental needs and development demands within the catchment.

The framework for groundwater management options used in report SLUI 2 and here comes from the Environmental Planning Precincts of Evangelisti & Associates. Figure 7 shows these Environmental Planning Precincts and Table 2(a and b) provides a range of management actions.

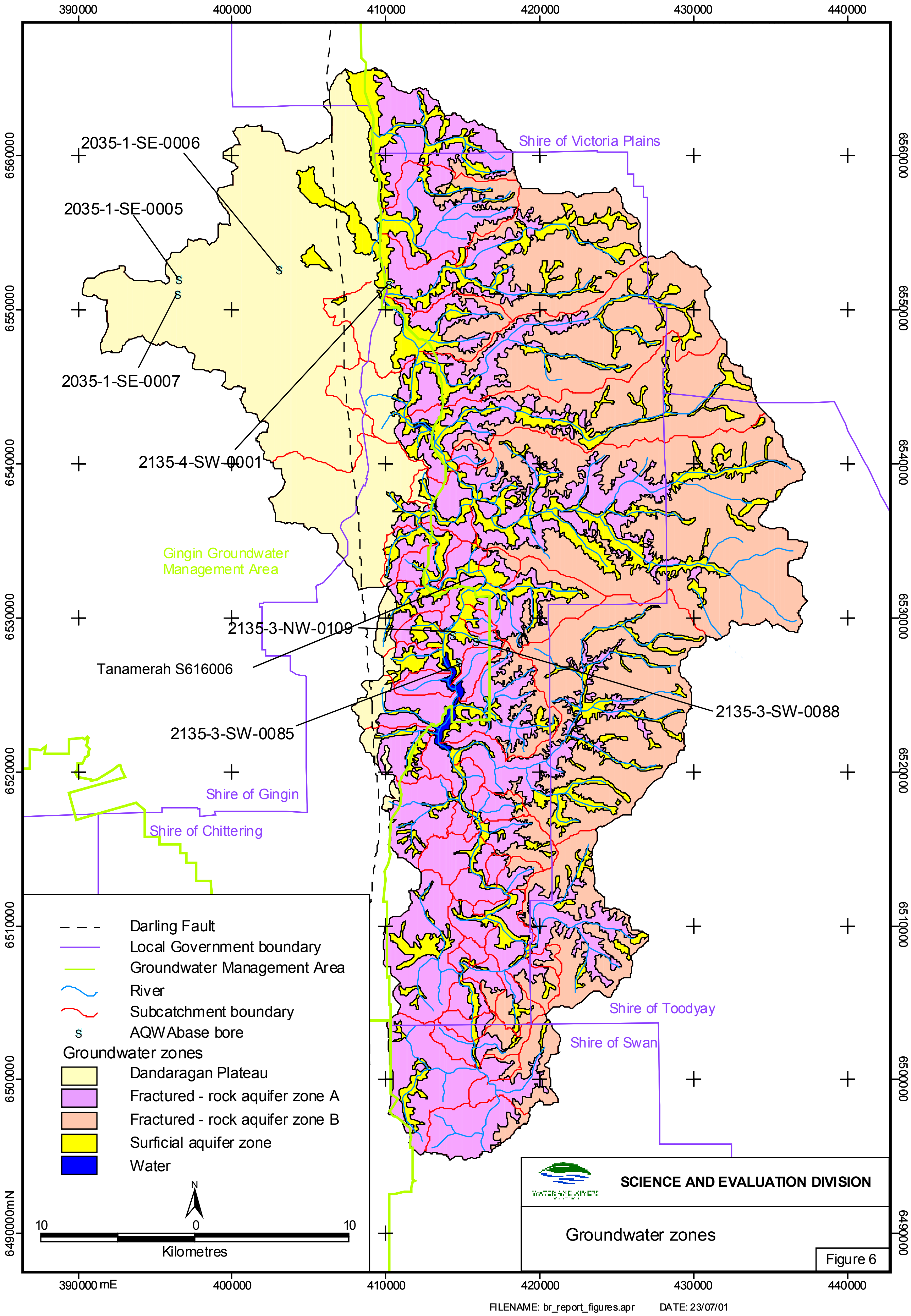
2.1 Management guidelines

Table 2a. Summary of management options for limited groundwater resource

Groundwater management objective	*Priority areas*	*Recommended actions*	*Examples/actions*
Use groundwater efficiently.	A) Environmental Planning Precincts DR2, DR3, DR4, DR5, DR6 and DR9 which are predominantly within the surficial aquifer zone and fractured-rock aquifer zone A. B) The regional aquifer system located on the Dandaragan Plateau.	**Efficient use of groundwater**	Ensure that appropriate land use activities are carried out within the Brockman River catchment. Encourage the use of appropriate quality water for industrial and agricultural activities; i.e.do not use low salinity/fresh groundwater if brackish groundwater is suitable.
Protect existing groundwater sources	As above	**Industry awareness of best management practices**	Identify groundwater issues related to specific industries, such as nutrient discharge associated with piggeries; fuel leakage from fuel storage tanks (commercial and private); and contamination from waste disposal sites. Ensure that industry is employing best management practices and monitor issues related to groundwater if deemed necessary. Facilitate industry education; i.e. workshops and field days. Ensure correct disposal of solid and liquid waste, and waste water from existing light industry, agricultural and horticultural activities.
		Public awareness and education	Education regarding the storage, usage and disposal of chemicals, fertilisers, pesticides and herbicides at both the household and business levels. Encourage the use of native plants in the gardens to reduce the use of chemicals like fertilisers, pesticides and herbicides. Native plants also require minimal watering in summer, thus preserving existing groundwater supplies. Education on the interdependence of rivers and groundwater, to illustrate the relevance of groundwater quality to a healthy river system.

Table 2b. Summary of management options for dryland salinisation

Groundwater management objective	*Priority areas*	*Recommended actions*	*Examples/actions*
Reduce groundwater recharge	Subcatchments within Environmental Planning Precincts DR7, DR8, DR9 and DR13. Rising groundwater levels and salinisation are evident throughout the catchment.	**Manage groundwater recharge**	Commercial farm forestry, Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species. Management of native vegetation and revegetation. Engineering practices: surface-water management via shallow interceptor banks or grade banks.
Lower groundwater level	As above	**Manage the groundwater recharge and engineering options**	Reducing groundwater recharge as above. Engineering options: deep drains (> 1.5m deep), not effective in deep clays; groundwater pumping; relief wells or siphons where depth to groundwater is less than 4 m and land surface has slope greater than ~ 3%.
Evaluate remedial actions	As above	**Monitoring**	Monitoring program either site specific or at catchment level.
Public support of management actions	As above	**Increased public education and awareness**	Public information on catchment targets and why they were selected. Education on the causes and management of salinisation. Reinforce the key message that the whole community benefits from reducing salinity. Encourage active subcatchment groups and community participation. Encourage tours of remedial sites, both positive and negative.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Tanamerah S616006
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2135-3-SW-0088
Shire of Victoria Plains
Gingin Groundwater Management Area
Shire of Gingin
Shire of Chittering
Shire of Toodyay
Shire of Swan
Darling Fault
Local Government boundary
Groundwater Management Area
River
Subcatchment boundary
AQWAbase bore
Groundwater zones
Dandaragan Plateau
Fractured - rock aquifer zone A
Fractured - rock aquifer zone B
Surficial aquifer zone
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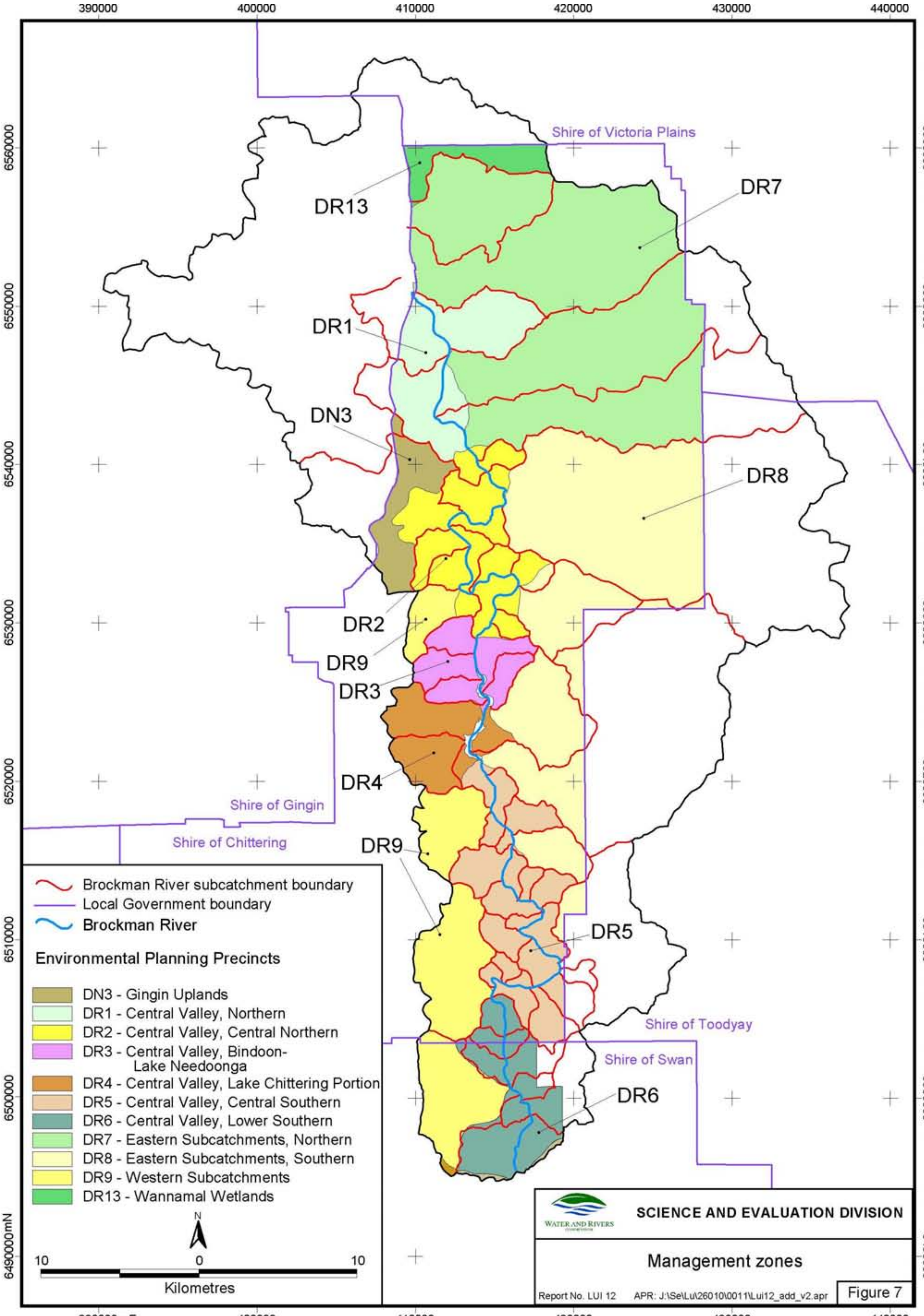

Shire of Victoria Plains
DR13
DR7
DR1
DN3
DR8
DR2
DR9
DR3
DR4
Shire of Gingin
Shire of Chittering
DR9
DR5
Shire of Toodyay
Shire of Swan
DR6
Brockman River subcatchment boundary
Local Government boundary
Brockman River
Environmental Planning Precincts
DN3 - Gingin Uplands
DR1 - Central Valley, Northern
DR2 - Central Valley, Central Northern
DR3 - Central Valley, Bindoon-Lake Needoonga
DR4 - Central Valley, Lake Chittering Portion
DR5 - Central Valley, Central Southern
DR6 - Central Valley, Lower Southern
DR7 - Eastern Subcatchments, Northern
DR8 - Eastern Subcatchments, Southern
DR9 - Western Subcatchments
DR13 - Wannamal Wetlands
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Figure 7

3 Upper Canning Southern Wungong catchment

The Upper Canning Southern Wungong catchment is a near-urban composite catchment (Fig. 8) undergoing major land use changes and development. The major changes since European settlement have already resulted in erosion, waterlogging, water quality degradation, dryland salinisation and contamination of groundwater resources.

The catchment has a diverse geology and this has a major influence on the occurrence and vulnerability of water to land use practices. Consequently, the occurrence and quality of groundwater is most highly variable from east to west across the main geologic changes (Fig. 9). Furthermore, fresh groundwater is localised and limited in the eastern half of the catchment, while large groundwater resources are present in the western third of the area.

Erosion is significant mainly where the surface is clayey and the landscape steep, particularly the valleys and scarps of the Darling Plateau (Fig. 10). There is major erosion in cleared areas, especially along streamlines where there is stock access and land development.

Shallow watertables in the clayey areas in the east of the Swan Coastal Plain and in the Darling Plateau can contribute to waterlogging and inundation of low-lying poorly drained land.

Groundwater in sandy surficial sediments varies in quality, may contain isolated very high nutrient levels at the watertable or at depth, and transports nutrients in solution from the western part of the catchment into the Southern River.

Nutrients enter the Upper Canning and Southern rivers bound to eroding soil particles especially where ridges, slopes and drainage lines are poorly vegetated and used by stock and humans.

Land clearing on the Darling Plateau is the cause of localised mobilisation of salt stored in the soil profile, leading to the discharge of saline groundwater and land salinisation.

Investigations of groundwater contamination from land use, particularly landfill and liquid waste disposal, are well documented.

Report SLUI 14 describes the current status and processes occurring in the catchment, gives guidelines for management of future development, and discusses the impact on land and water quality, in particular groundwater. The suggested range of management actions is given in Table 3(a to e).

3.1 Management guidelines

Table 3a. Management options to control erosion by water

(The numbers refer to subcatchments named on Figure 8)

Groundwater management objective	*Priority areas by subcatchments*	*Recommended actions*	*Examples/actions*
Limit shallow watertables	Areas with steep slopes in parts of 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 24, 25, 26, 27.	Adequate drainage	Restrict grazing Plant high water using trees Use appropriate land/farming practice Engineering practices: surface water management via shallow interceptor banks or grade banks
Limit groundwater discharge on steep slopes	Areas with steep slopes in parts of 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 24, 25, 26, 27.	Stabilise slopes	Restrict grazing Plant high water using trees Use appropriate land/farming practice Engineering practices: surface water management via shallow interceptor banks or grade banks
Limit groundwater discharge onto unprotected stream banks	Stream banks, scarps and major rivers 6, 9, 13, 14, 15, 16, 17, 18, 21, 22, 24, 25, 26, 27,	Stabilise banks	Increase or improve riparian vegetation Fence stream lines Reduce stock access to stream line

Table 3b. Management options to control inundation and waterlogging

Groundwater management objective	*Priority areas by subcatchments*	*Recommended actions*	*Examples/actions*
Limit rising shallow watertable Limit waterlogging	Flat poorly drained clayey ground, especially along and east of Southern River, in 6, 8, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25	Control watertable rise to keep watertable below surface	Plant high water-use trees Adequate urban drainage Commercial farm forestry, Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Engineering practices: surface water management via shallow interceptor banks or grade banks
Limit shallow “perched” watertable	Areas of laterite weathering profiles, in parts of 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 24, 25, 26, 27	Use or drain shallow “perched” groundwater	Maintain or restore healthy high water use vegetation, eg forestry preferable to pasture Planting species tolerant to waterlogging

Table 3c. Management options to reduce nutrient export

Groundwater management objective	*Priority areas by subcatchments*	*Recommended actions*	*Examples/actions*
Limit near surface groundwater flow (in winter)	Areas with thin sands over shallow clays, in 8, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23. Minor areas in 25, 26, 27.	Reduce saturation in winter. Keep watertable out of sandy layer Intercept shallow flow	Drainage High water use vegetation Commercial farm forestry - Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Perennial pasture Vegetation belts and wetlands and swales
Manage throughflow of groundwater	Where there is a sandy layer and where there is hydraulic connection with river, in 8, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23. Minor areas in 25, 26, 27.	Minimise leaching to watertable	Fertiliser & irrigation management Improve land practice Application of soil amendment to low phosphorus-retaining soils
Manage overland flow, (in the wet season)	Where surface is Guildford clay, ie 8, 9, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 25	Surface water control	Stream lining to trap and uptake nutrients Planting, graded bank to reduce overland flow
Limit sediment entry to drainage	Areas of groundwater discharge, shallow clay and flat areas. Steep slopes of valleys on Darling Plateau, slopes of Darling Scarp. Along river valleys and banks of Darling Plateau, Swan Coastal Plain, in 3, 4, 5, 6, 10, 11, 12, 13, 14, 15, 18, 21, 24, 25, 26, 27.	Control surface runoff	Streamlining Stabilise slopes and stream banks Planting to filter sediments Planting, fencing, stock control to reduce erosion Perennial pastures

Table 3d. Management options to counter dryland salinisation

Groundwater management objective	*Priority areas by subcatchments*	*Recommended actions*	*Examples/actions*
Limit mobilisation of stored salt	Where deep rooted trees have been cleared and there is deep saline groundwater, especially poorly drained clays, for example on the Darling Plateau, in 1, 2, 3, 4, 5, 6. Minor areas in 7, 10, 11, 12, 13, 14, 15, 24, 26, 27.	Manage groundwater recharge	Control clearing Plant deep rooted salt-tolerant vegetation Commercial farm forestry, Maritime pine, Eucalyptus, Oil mallees, Acacias, and other tree species Management of native vegetation and revegetation Engineering practices: surface water management via shallow interceptor banks or grade banks
Slow drainage and evaporative concentration	Near surface clay, in 6, 8, 9, 14, 15, 21, 22, 23, 25. Minor areas in 18, 19, 20.	Maintain or lower watertable, e.g. below 2m	Control clearing Plant deep rooted high water use trees

Table 3e. Management options to limit point source contamination of groundwater

Groundwater management objective	*Priority areas by subcatchments*	*Recommended actions*	*Examples/actions*
Limit point source contamination of groundwater	Industrial sites Waste disposal sites Landfill sites especially on Bassendean Sand mainly 9, 18, 19, 20, 21.	Protect groundwater	License land use Monitoring Educate on industrial Best Management Practice Review the appropriateness of land use

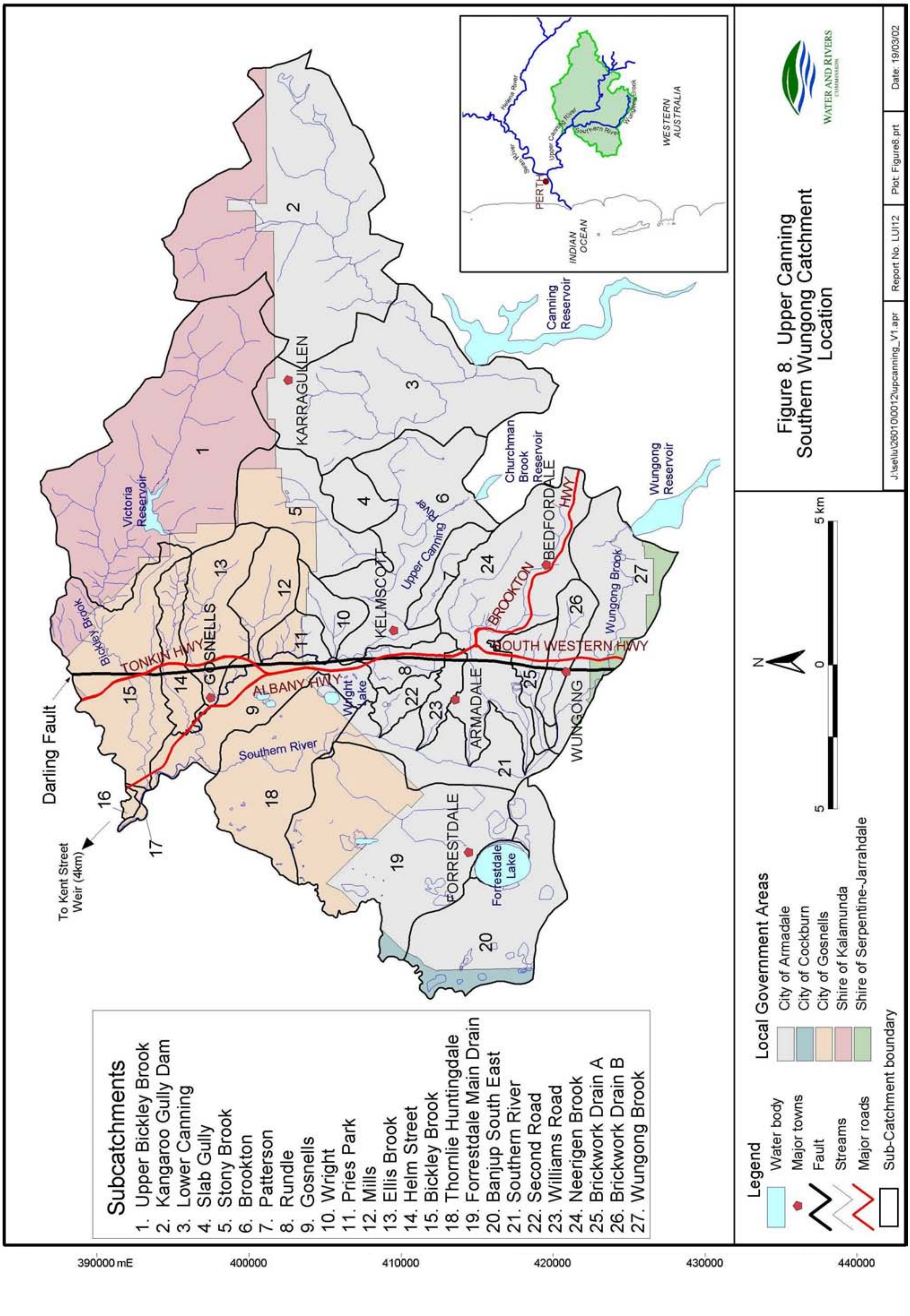

Figure 8. Upper Canning Southern Wungong Catchment Location

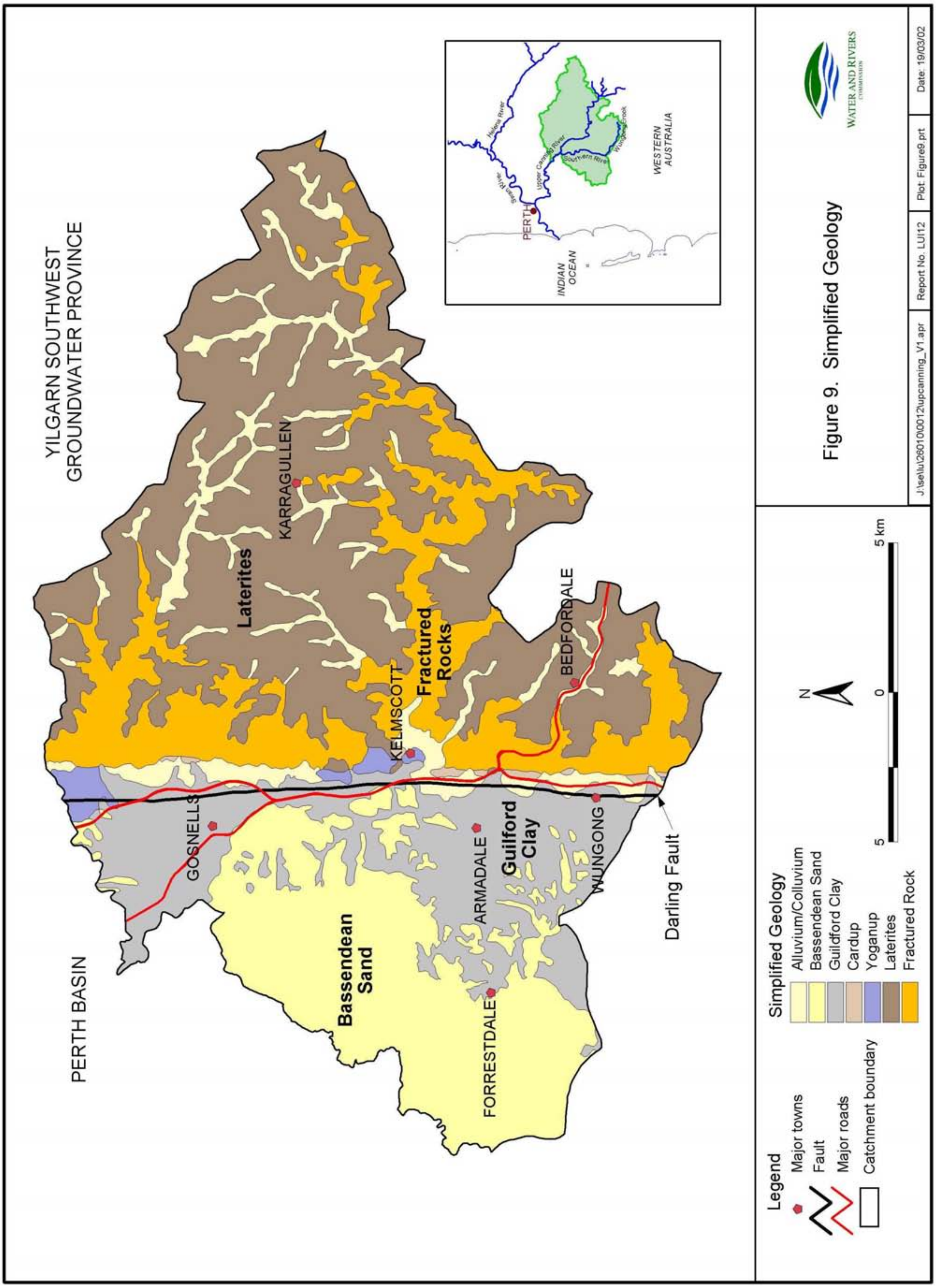

Figure 9. Simplified Geology

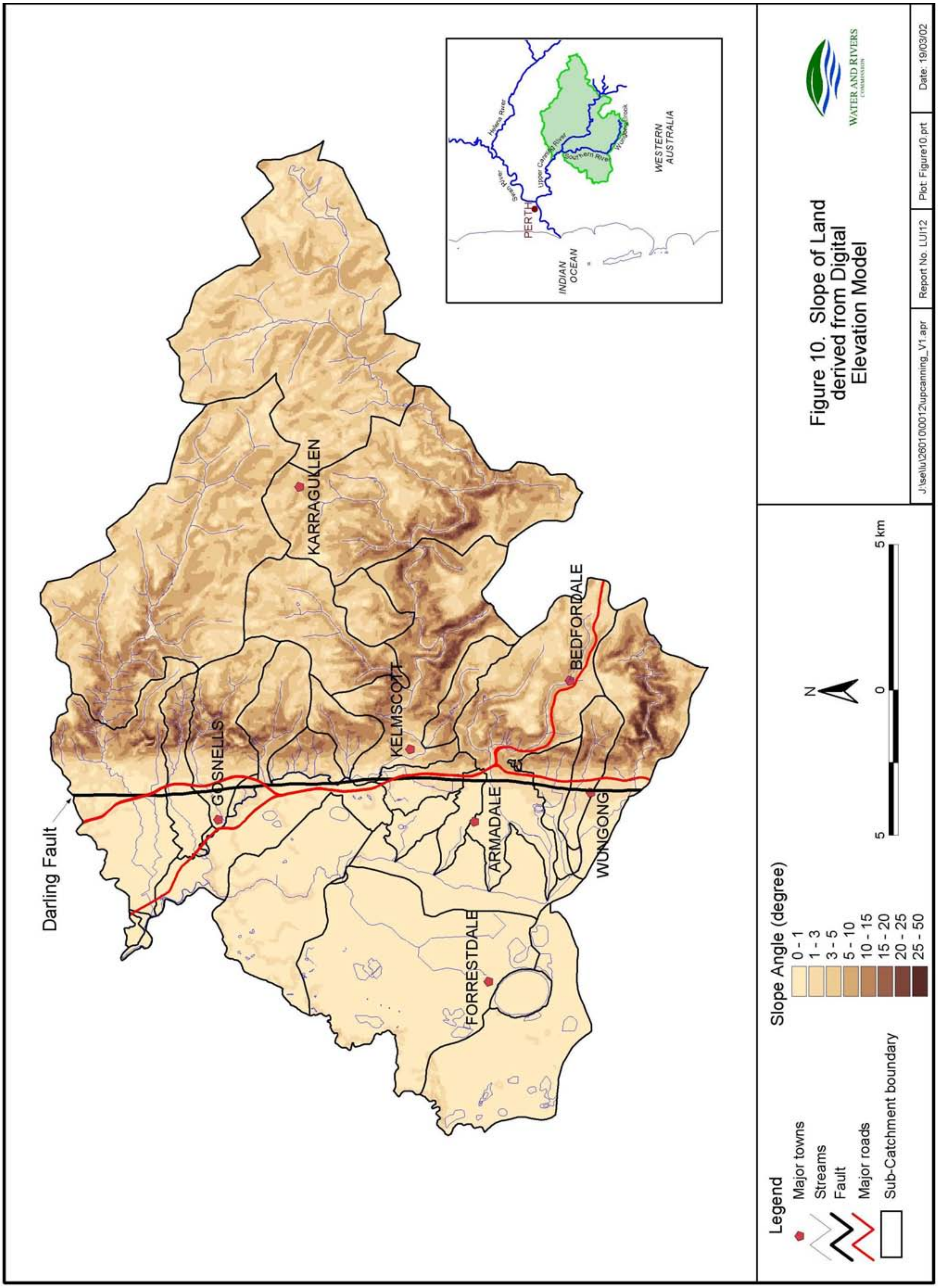

Figure 10. Slope of Land derived from Digital Elevation Model

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